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Performance of *Solanum melongena* L. grown in Municipal Solid waste (Viz. Kitchen Waste) Compost Amended Soils

AWADHESH KUMAR PATHAK[1], M. M. SINGH[2] and VINIT KUMAR[1]

[1]Institute of Environment and Development Studies,
Bundelkhand University, Jhansi, U.P., INDIA.
[2]Department of Geology,
Bundelkhand University, Jhansi, U.P., INDIA.

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ABSTRACT

Municipal Solid waste (Viz. Kitchen Waste) compost from Jhansi city Uttar Pradesh (India) was used for amending soil at levels Control, 60, 120, 180 and 240 tons ha^{-1} in which, *Solanum melongena* L. has been grown and elemental residues of amended soil and plant parts were enumerated. Municipal Solid waste (Viz. Kitchen Waste) compost amendments caused significant improvement in soil quality and composition of photosynthetic pigment (chlorophyll a, chlorophyll b, total chlorophyll and Carotenoid) and yield per plant of *Solanum melongena* L with the increase in Municipal Solid waste (Viz. Kitchen Waste) compost amendments. Edible part of *Solanum melongena* L grown in Municipal Solid waste (Viz. Kitchen Waste) compost amended soils accumulated Cr, Cu, Zn, Fe, Pb and Cd. Based on the data obtained we found that soil amended at 180 tons Municipal Solid waste (Viz. Kitchen Waste) compost per ha level of Municipal Solid waste (Viz. Kitchen Waste) compost not only improved the physical properties of the soil but also contributed to better growth and yield of *Solanum melongena* L in red soil of Bundelkhnad region.

Keywords: *Solanum melongena* L, Municipal Solid waste, photosynthetic pigments.

1. INTRODUCTION

Composting is the regulated decom-posetion of organic matter to produce a final product called compost; it is used in waste management as a method to recover organic waste (Haight 2006). The composting process entails managing and accelerating

the biological and oxygen demanding process as a mixture of organic materials pass through a series of stages that are characterized by increases in temperature and bacterial types leading to a stable organic material called compost (Haight and Taylor 2000). Composting of organic waste is recognized as an effective method to manage this waste type as it aims to recovers organic waste in the waste stream and produces a useful end-product (Hoornweg 1999).

Composting of municipal solid waste (MSW) and its subsequent application to agricultural land is gaining popularity because of environmental concerns associated with the disposal of this material in landfills. Several studies have shown that use of MSW compost in agriculture has many benefits to soil, crops and environment (Roe *et al*., 1993; Hicklelenton *et al*., 2001). The aim of this study was to assess the Growth and yield in *Solanum melongena* L. grown in Municipal Solid waste (Viz. Kitchen Waste) compost amended soils.

2. MATERIAL AND METHODS

2.1 Study area:

The study site is located in Jhansi city of Bundelkhand district Uttar Pradesh. The municipal solid wastes (Kitchen waste) were collected from the dumping site recognized by Municipal Corporation of Jhansi Calan shah, Alligole, Mella ka Torya (behind Ras Bihar colony), Sujakhan Kidki (U.P.) India. The district is situated in the South West corner of the region at 24º11' - 25º57' N latitude and 78º10' - 79º23' E longitudes.

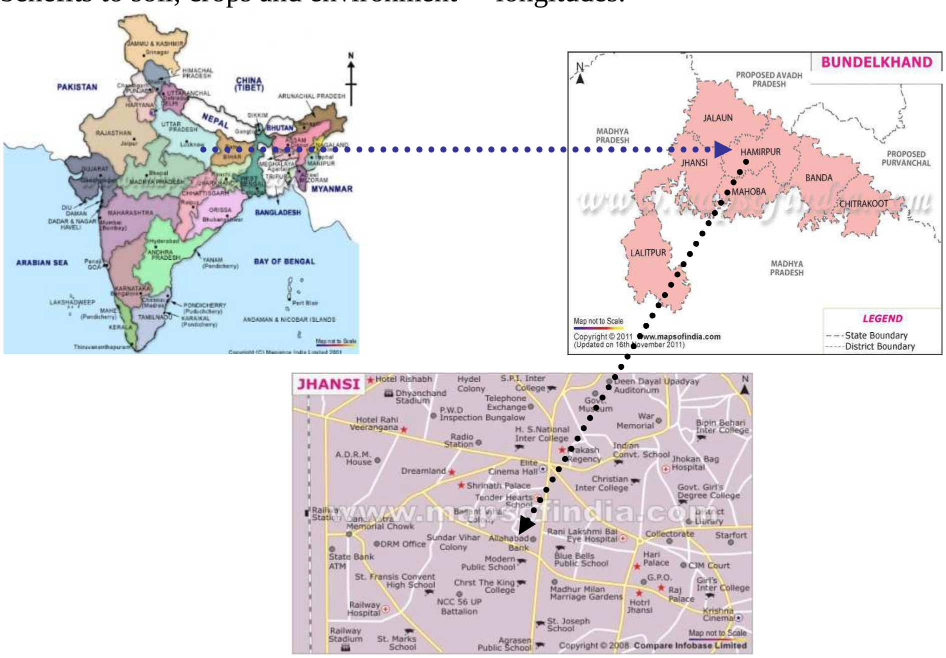

Fig 1. Location of study area

2.2 Physico-chemical analysis of different amendment and soil:

Municipal Solid waste (Viz. Kitchen Waste) compost and soil samples were collected randomly from different locations in large plastics bags and brought to the laboratory. The Municipal Solid waste (Viz. Kitchen Waste) compost and soil were dried 5 days and passed through 2 mm sieve before making various amendments (manually) plots were 1 x 1m size with 15 cm uniform spacing between plots and 30 cm ridges between adjacent plots and five treatments i.e. 0, 60,120, 180 and 240 t/ha respectively were taken (Mishra et al, 2007).

Physico-chemical analysis was carried out in triplicate on soil and their different amendments with Municipal Solid waste (Viz. Kitchen Waste) compost before the growth of *Solanum melongena* L. The pH of the different amendment was measured in 1 : 2.5 soil water suspension using pH meter (Consort C831), electrical conductivity (EC) expressed in µs/cm of soil and amendments samples was determined following 30 min equilibrium in mechanical shaker a digital conductivity meter (Consort C831).

Organic carbon values of soil and amended samples were determined by oxidation with potassium dichromate in acid medium (Walkley and Black 1934), to lots of .5 gm of air dried and sieved soil/ Municipal solid waste (viz. Kitchen Waste) compost samples, aliquots of 10 ml of 1 N K_2Cr2O_7 solution, 20 ml of 12 N H_2SO_4 and 1.25% Ag SO_4 were added with constant stirring. After incubation for 30 min to each sample volume of 200 ml distilled water added followed by addition of 10 ml phosphoric acid (85%) 1 ml (0.42 %). The indicator phenyl amine and titrated against 1 N ferrous ammonium sulphate. Total concentrations of trace elements were determined with Hydrogen fluoride, Nitric acid and Perchloric acid (7:3:1) using through with AAS (Perkin Elmer 200).

2.3 Experimental design:

Certified seeds of *Solanum melongena* L. were obtained from Jhansi City (UP) India. All the seed were sterilized with 0.1 % mercuric chloride for 5 min to avoid fungal contamination and washed with distilled water for three times and soaked in water 5 h. The soaked seed were evenly shown in pot (10 in diameter), which were filled with different amendments (60,120, 180, and 240 t/ha of 7 kg, along with one set of control (soil) each in pot to a depth of 0.5 cm and watered daily till seed germination. The plants were irrigated with tap water at regular (300 ml) avoiding leakage of water from the pots and measured root and shoot length respectively.

Leaves of plants 45 and 90 days after germination were used for biochemical analysis (Chlorophyll a, Chlorophyll b, Total Chlorophyll and Carotenoid using with Arnon 1949) .1 gm of (fresh weight) of leaves (Three replicates) samples were crushed with 10 ml of 80 % acetone v/v. After centrifugation at 10000 rpm for 10 min, optical densities of acetone soluble pigments were determined at 643 and 645, 480 and 510 nm. Total concentrations of metal in plant parts were determined with nitric perchloric acid (3:1) using through with AAS (Perkin Elmer 200).

3. RESULTS AND DISCUSSION

3.1 Plant Growth, photosynthetic responses and accumulation of elements

Effect on Shoot length (cm) of *Solanum melongena* L. after amendment with Municipal Solid Waste (Viz. Kitchen Waste) compost at two seasons in red soil are depicted in table 3.1 to 3.3. Max Shoot length (cm) of *Solanum melongena* L. in red soil recorded as 41.97 in 2010, it is significantly affect as compare to control environment. Performance of plants and their response toward Municipal Solid Waste (Viz. Kitchen Waste) compost amendments for all seasons were given in table 3.1 to 3.9. It is found that all were significantly increased with increasing soil/ Municipal Solid Waste (Viz. Kitchen Waste) compost amendment ratio as compared the control set. The plant growth was better in 60 t/ha 120 t/ha 180 t/ha and 240 t/ha combinations in comparison of control.

Effect on Root length (cm) of *Solanum melongena* L. after amendment with Municipal Solid Waste (Viz. Kitchen Waste) compost at two seasons in red soil are depicted in table 3.4 to 3.5. Max Root length (cm) of *Solanum melongena* L. in red soil recorded as 11.20 in 2010 after 90 days of harvesting. It is significantly affect as compare to control environment.

Effect on Fresh and Dry weight of Edible part (g/pot) of *Solanum melongena* L. after amendment with Municipal Solid Waste (Viz. Kitchen Waste) compost at two seasons in red soil are depicted in table 3.6 & 3.7.

This part of study deals the effect of different amendments of Municipal Solid Waste (Viz. Kitchen Waste) compost on chlorophyll and Carotenoid content (mg/kg FW) of *Solanum melongena* L. in two consecutive year 2010 and 2011. The data were depicted in the Tables (3.8 & 3.9) after 45 & 90 days of harvesting in red soil.

The photosynthetic pigments (chlorophyll a, chlorophyll b, total chlorophyll and Carotenoid) were significantly increased in the treatments with 120 to 180 t/ha Municipal Solid Waste (Viz. Kitchen Waste) compost as compared with control Decrease chlorophyll content may also be ascribed due to decreases in carotenoids contents, a non-enzymatic antioxidants playing a important role in protection of chlorophyll pigments against a stress.

Accumulation of elements (mg/kg) like Cr, Cu, Zn, Fe, Pb, Cd, has increased with the increase in amendment ratio in edible parts after 90 days. Different amendments of Municipal Solid Waste (Viz. Kitchen Waste) compost and there significant values were shown in table 3.10 to 3.12. Plants grown in Municipal Solid Waste (Viz. Kitchen Waste) compost have accumulated appreciable amounts of these metals than plants grow in control. However general vigour of plant was not affected.

The data representing in Tables 3.1 and 3.9 showed that all the plant growth parameters and photosynthetic pigments (root length, and fresh weight edible part) were significantly increased at all amendment in Municipal Solid waste (Viz. Kitchen Waste) compost combinations as compared to control set. The plant growth was better in 60 t/ha 120 t/ha 180 t/ha and 240 t/ha combinations irrespective of control, maximum being at 120 -180t/ha level of Municipal solid waste (viz. Kitchen

Waste) compost. The photosynthetic pigments (chlorophyll a chlorophyll b, total chlorophyll and carotenoid) were significantly increased in the treatments with 120 to 180 t/ha Municipal solid waste (viz. Kitchen Waste) compost as compared with soil. The beneficial effect of Municipal Solid waste (Viz. Kitchen Waste) compost at lower levels have already been observed on many crops - soybean, cabbage, chickpea, cucumber, lentil, maize, potato, wheat, tomato etc. (Kausar, 2007).

Table 3.1 Effect of Different Treatment of Municipal Solid Waste (viz.Kitchen Waste) compost on shoot length of *Solanum melongena* L. (inch) at different durations in 2010 in red soil.

Treatment (T/Ha)	Days					
	15	30	45	60	75	90
Control	1.05±0.02	4.51±0.05	8.02±0.14	12.64±0.03	26.60±0.25	29.00±0.49
60t/ha	1.54±0.18	4.64±0.03	8.69±0.03	13.76±0.07	29.77±1.20	32.39±0.78
120 t/ha	1.39±0.05	5.35±0.02	9.01±0.05	14.39±0.05	31.77±0.38	34.03±0.97
180 t/ha	1.58±0.15	5.71±0.18	9.19±0.19	15.31±0.03	35.54±0.93	38.30±0.44
240 t/ha	1.33±0.01	6.77±0.06	9.90±0.05	15.90±0.34	35.91±0.36	41.97±0.07

Values are Mean ± SE (n=3), Significant at $p < 0.05$.

Table 3.2 Effect of Different Treatment of Municipal Solid Waste (viz. Kitchen Waste) compost on shoot length of *Solanum melongena* L. (inch) at different durations in 2011 in red soil.

Treatment (T/Ha)	Days					
	15	30	45	60	75	90
Control	1.22±0.08	4.53±0.06	8.82±0.14	12.64±0.03	25.18±0.28	26.60±0.08
60t/ha	1.33±0.10	4.62±0.04	9.19±0.03	13.76±0.07	30.25±0.43	33.54±0.63
120 t/ha	1.38±0.05	4.80±0.00	9.98±0.06	14.36±0.08	31.00±0.52	34.47±0.23
180 t/ha	1.55±0.18	5.72±0.22	10.15±0.22	15.26±0.02	35.81±0.91	37.27±0.17
240 t/ha	1.33±0.01	6.65±0.03	10.85±0.03	16.63±0.08	34.83±0.87	40.48±0.36

Values are Mean ± SE (n=3), Significant at $p < 0.05$

3.3 Comparison between different amendments of Solid Waste (viz. Kitchen Waste) compost on shoot length of *Solanum melongena* L. at different years indifferent soil after harvesting.

Parameter	Red Soil			
	Year	Treatment	Year*Treatment	Days
SE (d)	0.088	0.098	0.197	0.107
C. D. (P=0.05)	0.173	0.194	0.388	0.212

Table 3.4 Effect of Different Treatment of Municipal Solid Waste (viz. Kitchen Waste) compost on root length of *Solanum melongena L.* (inch) at different years in Red soil after 45 and 90 days of hervesting.

Treatment (T/Ha)	2010		2011	
	45 days	90 days	45 days	90 days
Control	3.74±0.347	5.83±0.151	3.60±0.200	5.53±0.153
60t/ha	4.44±0.115	6.77±0.113	4.72±0.120	6.60±0.293
120 t/ha	6.33±0.067	9.48±0.192	6.35±0.088	9.51±0.250
180 t/ha	7.39±0.168	11.20±0.115	7.43±0.115	11.06±0.610
240 t/ha	5.57±0.346	8.30±0.127	5.36±0.078	8.36±0.205

Values are Mean ± SE (n=3), Significant at $p < 0.05$,

Table 3.5 Compression between different amendment of Solid Waste (viz. Kitchen Waste) compost on root length of *Solanum melongena* L. at different years indifferent soil after harvesting.

Parameter	Red Soil		
	Year	Treatment	Days
SE (d)	0.027	0.03	**0.019**
C. D. (P=0.05)	0.0543	0.06	**0.038**

Table 3.6 Effect of Different Treatment of Municipal Solid Waste (viz. Kitchen Waste) compost on edible part of *Solanum melongena L.* (gm/pot) at different years in red soil.

Treatment (T/Ha)	2010		2011	
	F weight	D Weight	F weight	D Weight
Control	229.70±4.386	10.86±0.454	229.71±2.814	11.62±1.517
60t/ha	293.14±2.030	16.17±0.968	295.47±3.175	15.87±1.754
120 t/ha	324.37±4.967	19.20±2.858	326.82±10.132	20.27±4.516
180 t/ha	415.60±1.992	18.37±2.233	414.60±2.219	21.48±4.562
240 t/ha	485.60±1.552	22.37±2.333	494.60±2.249	27.48±3.542

Values are Mean ± SE (n=3), Significant at $p < 0.05$.

Table 3.7 Compression between different amendments of Solid Waste (viz. Kitchen Waste) compost on root length of *Solanum melongena* L. at different years indifferent soil after harvesting.

Parameter	Red Soil				
	Fresh Weight			Dry Weight	
	Year	Treatment		Year	Treatment
SE (d)	2.866	3.205		0.559	0.625
C. D. (P=0.05)	5.793	6.477		1.129	1.263

Table 3.8 Effect of Different Treatment of Municipal Solid Waste (viz. Kitchen Waste) compost on photosynthetic pigments of *Solanum melongena L.*(gm/pot) at 45 days in different years in red soil.

Treatment (T/Ha)	2010				2011			
	Ch. a	Ch. b	Total ch.	Carotenoid	Ch. a	Ch. b	Total ch.	Carotenoid
Control	1.17±0.025	0.64±0.044	1.81±0.055	0.22±0.025	1.17±0.043	0.62±0.046	1.79±0.088	0.26±0.042
60t/ha	1.25±0.066	0.73±0.056	1.98±0.020	0.26±0.064	1.29±0.036	0.73±0.049	2.02±0.085	0.27±0.038
120 t/ha	1.50±0.136	0.75±0.047	2.25±0.182	0.36±0.163	1.47±0.070	0.75±0.041	2.22±0.111	0.27±0.021
180 t/ha	1.58±0.166	0.74±0.036	2.32±0.198	0.49±0.075	1.49±0.053	0.76±0.025	2.25±0.079	0.44±0.115
240 t/ha	1.53±0.309	0.69±0.008	2.22±0.306	0.44±0.089	1.38±0.170	0.80±0.166	2.18±0.323	0.42±0.118

Values are Mean ± SE (n=3), Significant at $p < 0.05$.

Table 3.9 Effect of Different Treatment of Municipal Solid Waste (viz. Kitchen Waste) compost on photosynthetic pigments of *Solanum mrlongena L.* (gm/pot) at 90 days in different years in red soil.

Treatment (T/Ha)	2010				2011			
	Ch.a	Ch. b	Total ch.	Caretenoid	Ch. a	Ch. b	Total ch.	Caretenoid
Control	1.19±0.04	0.57±0.11	1.75±0.15	0.59±0.06	1.2133±0.101	0.63667±0.032	1.85±0.123	0.5953±0.062
60t/ha	1.41±0.03	0.77±0.11	2.18±0.13	0.67±0.11	1.41±0.036	0.75333±0.112	2.1633±0.136	0.67±0.105
120 t/ha	1.51±0.14	0.86±0.11	2.37±0.24	0.91±0.12	1.49±0.053	0.86±0.114	2.35±0.166	0.8833±0.105
180 t/ha	1.72±0.15	0.97±0.12	2.68±0.26	0.97±0.03	1.7167±0.046	0.94833±0.066	2.665±0.111	0.9667±0.032
240 t/ha	1.74±0.27	0.79±0.20	2.53±0.40	0.74±0.12	1.2133±0.107	0.745±0.120	1.9583±0.218	0.74±0.122

Values are Mean ± SE (n=3), Significant at $p < 0.05$,

Table 3.10 Concentration of trace elements in root of *Solanum melongena L* in different years in red soil

Parameters (mg/kg)	Treatment (t/ha) 2010					Treatment (t/ha) 2011				
	Control	**60 t/ha**	**120 t/ha**	**180 t/ha**	**240 t/ha**	**Control**	**60 t/ha**	**120 t/ha**	**180 t/ha**	**240 t/ha**
Cr	0.14± 0.007	0.55± 0.0004	0.62± 0.0006	0.90± 0.0006	0.99± 0.0005	0.17± 0.0005	0.69± 0.0005	0.76± 0.033	0.86± 0.006	0.92± 0.006
Cu	0.36± 0.0022	9.63± 0.0006	9.94± 0.0003	11.35± 0.0007	11.96± 0.0005	0.39± 0.0005	9.49± 0.0049	9.94± 0.0025	10.15± 0.056	11.06± 0.006
Zn	0.84± 0.0006	27.54± 0.0006	28.32± 0.0007	22.32± 0.0008	24.12± 0.0004	0.89± 0.0003	28.54± 0.0016	29.92± 0.0016	30.23± 0.0032	31.22± 0.004
Pb	0.66± 0.0006	0.81± 0.0008	0.89± 0.0006	0.92± 0.0005	1.08± 0.0004	0.69± 0.0007	0.91± 0.0008	0.93± 0.0021	0.93± 0.0013	0.99± 0.006
Fe	0.73± 0.0005	56.21± 0.0002	73.82± 0.0005	65.22± 0.0006	62.42± 0.0021	0.72± 0.0002	79.51± 0.0512	80.12± 0.0112	85.13± 0.0009	87.92± 0.004
Cd	0.016± 0.0003	0.037± 0.0006	0.063± 0.0006	0.089± 0.0006	0.011± 0.0002	0.018± 0.0003	0.019± 0.0005	0.02± 0.0005	0.022± 0.0006	0.027± 0.004

Values are Mean ± SE (n=3), Significant at $p < 0.05$.

Table 3.11 Concentration of trace elements in shoot of *Solanum melongena L* in different years in Red soil

Parameters (mg/kg)	Treatment (t/ha) 2010					Treatment (t/ha) 2011				
	Control	**60 t/ha**	**120 t/ha**	**180 t/ha**	**240 t/ha**	**Control**	**60 t/ha**	**120 t/ha**	**180 t/ha**	**240 t/ha**
Cr	0.16± 0.0007	0.37± 0.0004	0.44± 0.0009	0.54± 0.0009	0.56± 0.0002	0.16± 0.0006	0.38± 0.0006	0.54± 0.0002	0.55± 0.0002	0.57± 0.0003
Cu	0.39± 0.0023	6.39± 0.0086	7.33± 0.0052	7.87± 0.0016	8.12± 0.0030	0.38± 0.0004	6.49± 0.0050	7.72± 0.0012	7.97± 0.0028	8.22± 0.0002
Zn	0.86± 0.0004	14.12± 0.0088	21.32± 0.0151	24.32± 0.0036	26.24± 0.0003	0.87± 0.0002	14.22± 0.0004	21.82± 0.0030	24.82± 0.0007	26.44± 0.0002
Pb	0.65± 0.0005	0.74± 0.0002	0.78± 0.0002	0.81± 0.0002	0.83± 0.0003	0.66± 0.0006	0.76± 0.0003	0.98± 0.0002	0.91± 0.0002	0.85± 0.0002
Fe	0.76± 0.0003	35.43± 0.0497	38.95± 0.0016	41.34± 0.0012	48.32± 0.0029	0.77± 0.0003	35.63± 0.0022	36.95± 0.0002	41.84± 0.0006	48.35± 0.0001
Cd	0.017± 0.0002	0.03± 0.0006	0.038± 0.0002	0.039± 0.0003	0.05± 0.0006	0.017± 0.0002	0.035± 0.0002	0.038± 0.0003	0.03± 0.0003	0.067± 0.0003

Values are Mean ± SE (n=3), Significant at $p < 0.05$,

Table 3.12 Concentration of trace elements in edible of *Solanum melongena L* in different years in red soil

Parameters (mg/kg)	Treatment (t/ha) 2010					Treatment (t/ha) 2011				
	Control	**60 t/ha**	**120 t/ha**	**180 t/ha**	**240 t/ha**	**Control**	**60 t/ha**	**120 t/ha**	**180 t/ha**	**240 t/ha**
Cr	0.16± 0.0007	0.13± 0.0002	0.16± 0.0006	0.21± 0.0004	0.22± 0.0005	0.16± 0.0006	0.14± 0.0002	0.18± 0.0004	0.24± 0.0004	0.25± 0.0004
Cu	0.39± 0.0023	1.14± 0.0022	1.23± 0.0042	1.27± 0.0003	1.35± 0.0006	0.38± 0.0004	1.15± 0.0005	1.33± 0.0002	1.28± 0.0005	1.36± 0.0037
Zn	0.86± 0.0004	0.46± 0.0007	0.52± 0.0005	0.54± 0.0003	0.56± 0.0002	0.87± 0.0002	0.47± 0.0002	0.53± 0.0003	0.56± 0.0002	0.58± 0.0003
Pb	0.65± 0.0005	0.36± 0.0012	0.44± 0.0004	0.56± 0.0003	0.59± 0.0004	0.66± 0.0006	0.46± 0.0003	0.45± 0.0004	0.57± 0.0002	0.61± 0.0004
Fe	0.76± 0.0003	1.13± 0.0019	1.18± 0.0003	1.21± 0.0025	1.29± 0.0005	0.77± 0.0003	1.14± 0.0003	1.19± 0.0003	1.25± 0.0010	1.31± 0.0078
Cd	0.017± 0.0002	0.03± 0.0006	0.03± 0.0004	0.04± 0.0003	0.04± 0.0004	0.017± 0.0002	0.03± 0.0004	0.04± 0.0001	0.04± 0.0002	0.04± 0.0008

Values are Mean ± SE (n=3), Significant at $p < 0.05$,

4. CONCLUSION

Soil application of Municipal Solid waste (Viz. Kitchen Waste) compost at lower levels (120-180 t/ha) were found beneficial for the plant growth and yield of *Solanum melongena* L in the present study. Thus application of Municipal Solid waste (Viz. Kitchen Waste) compost is more beneficial to plant growth and yield of *Solanum melongena* L as compared to control. This studies show that the available nutrients present in Municipal Solid waste (Viz. Kitchen Waste) compost was beneficial for certain levels for utilization of a particular plant species. Thus, Municipal Solid waste (Viz. Kitchen Waste) compost can be used as an eco-friendly non-conventional fertilizer because they will improve the growth and yield of plants. At the same time, the disposal problem of huge amount of Municipal Solid waste (Viz. Kitchen Waste) compost will also be solved.

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